



LLA Instruments GmbH

Multiplexed Near-Infrared-Spectrometer *KUSTA 4004M*



Product description

General information KUSTA 4004 series

The Near-Infrared Spectrometer, in short NIR-Spectrometer, *KUSTA 4004* are measuring devices for the qualitative and quantitative evaluation of solid or liquid samples. Different materials (as long as they are NIR active) can be identified and their composition determined. The samples are measured directly without any preparation, regardless of surface texture, moisture content and colour.

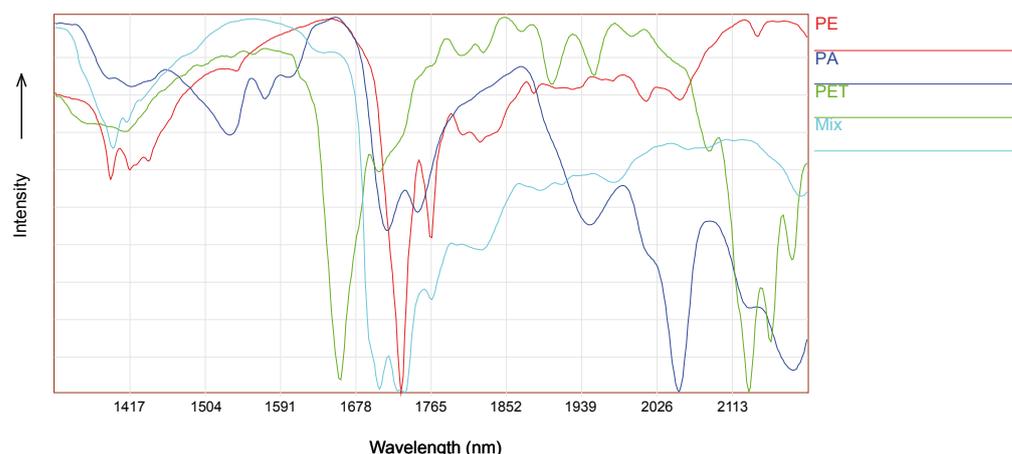
Two lines of *KUSTA 4004* exist. *KUSTA 4004S/C/P/L* for single sample point measurements (see separate document) and a *KUSTA 4004M* for simultaneous measurement of a number of measuring points.

For the *KUSTA 4004*, a range of measuring probes are offered, that are optimized for the operating conditions of the various applications.

Several hundred of *KUSTA M* devices are installed world-wide. Mainly in recycling plants for the identification of different sorts of plastic but also for paper sorting.

Principle of NIR Spectroscopy

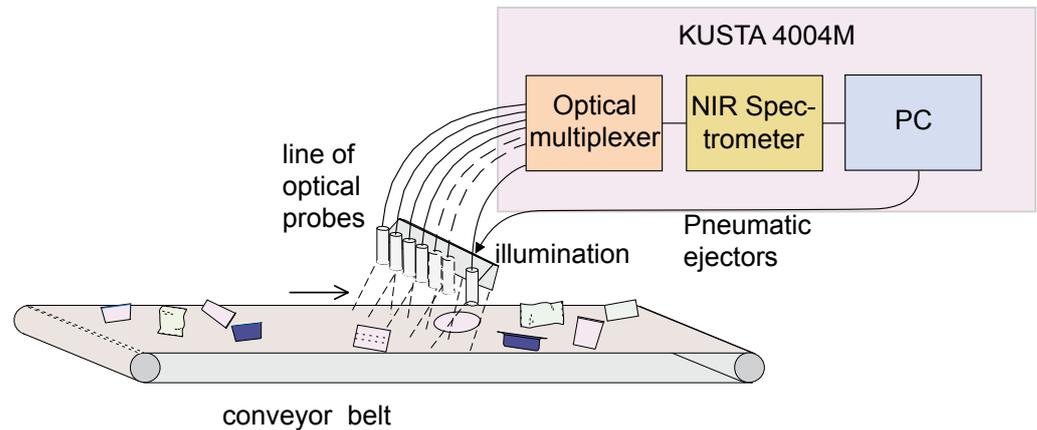
The NIR-Spectrometer *KUSTA 4004* are working on the basis of the re-mission spectroscopy. A light source, integrated into a probe, directs infrared light on the sample. This infrared light causes the molecular structure of the sample ingredients to swing. The swings withdraw energy from the light in defined spectral ranges. Different ingredients withdraw energy at characteristic wave lengths. Absorption bands appear in the spectrum which are characteristic for the ingredients. The light remitted from the sample (that includes the absorption bands) will be directed to an entrance slit of a spectrograph. The spectra will be recorded there by a line camera. The line camera transfers the measurement data after a user defined integration time via USB interface to the internal control PC.



In the graph above 4 distinctive spectra can be seen. A number of clear absorption bands (Intensity is low) can be seen between 1700 to 1765 nm. By the nm location of this point, the material of each of the samples can be identified.

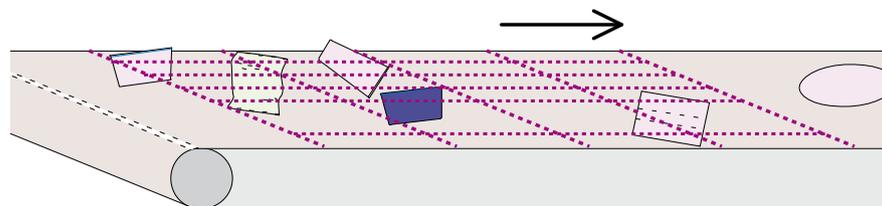
Functional principle of KUSTA M

The illustration below shows the working principle of *KUSTA 4004M*. A line of probes is usually installed above a conveyor belt. The probe line can include up to 64 probes, which are connected to an optical Multiplexer. This optical Multiplexer reads the measurement data from the probes within 20 milliseconds. Using 64 probes 5800 measurements are possible per second. Each measuring point on the belt is measured for 128 wave lengths in the interval between 1400 to 1910 nm with a dynamic range of 16 bit.



Resolution grid

The number of probes, i.e. measuring points, is chosen according to the size of the samples. For the identification of large samples a wide grid with less probes may be chosen, small samples require a tighter grid. An illustration of the grid can be seen in the figure below.



conveyor belt

The resolution grid has two dimensions. One across the belt, the other in belt movement direction. With probe lines like PTT a track width of 10 mm (across belt) can be achieved. Resolution in belt movement direction depends on the speed of the belt. For large samples a speed of up to 3 m/s is possible and still all samples will be identified.

KUSTA advantages

The *KUSTA 4004M* is during each measurement regarding wavelength and remission calibrated exactly. There are no position depending differences regarding calibration. This is a prerequisite for precise measuring results. Competing products with turning polygon mirrors can not be calibrated regarding remission. That means the measuring parameters are never determined and can change from one measuring point to the next. The measuring results are therefore less precise. A rough distinction between plastics is possible, but not a differentiation regarding polymeric details. A higher resolution grid of e.g. 4 x 4 mm does not solve that issue.

Versions of KUSTA 4004M

A *KUSTA* solution consists of three main components to be chosen according to the requirement:

- *KUSTA 4004M* including software package
- Probes or probe line and illumination
- fibre cables
- (third party components are necessary to complete a machine)

LLA does not deliver complete (sorting) machines. The LLA components are integrated by our OEM partners into complete machines. Typically mechanical components like conveyor belts and ejection units as well as logical components like a PLC are required to complete a machine.

KUSTA 4004M

The *KUSTA* itself consists of two physical building blocks, the Optical Multiplexer and the NIR spectrometer (including an industrial PC). Both blocks are designed to fit in a 19" rack. As standard option the two building blocks are delivered in an air conditioned housing. On request the two building blocks are also delivered separately (OEM versions: *KUSTA M/32-OEM*, *KUSTA M/64-OEM*) to be installed in an already existing housing. The Optical Multiplexer comes in two different versions - either for connection of up to 32 (*KUSTA M/32*) or up to 64 (*KUSTA M/64*) probes. During the online use, the *KUSTA* is typically controlled by the PLC. For manual input by the operator a touchscreen is integrated into the housing, providing shelter from rough environmental conditions. *KUSTA M* may be ordered with an optional colour sensor. Colour information is available on each probe together with the material information - no trade-off.

probes/ probe lines

A wide range of probes is offered for the *KUSTA*. Single probes like *PT* are suitable for the identification of large parts and can be arranged freely. Probe lines (i.e. a physical combination of single probes) on the other hand are provided with a fixed grid of probes, although that grid can be manufactured according to the requirement. Typical probe line widths are 1000 and 2000 mm.

All probes require illumination. Depending on the probe chosen, the illumination units are either integrated or delivered as separate units. Different probes and their main characteristics are shown in the table below:

Probe name	Measuring points	Samples	Illumination
PT	single	large	external
PM	up to 64	solid	integrated
PMW	up to 64	sliding solid	integrated
PMT	up to 64	foils	integrated
PTT	up to 64	flakes	external

The different probes are developed for special requirements. Measurement takes place in reflection (the from the sample reflected light is analysed) or transmission (the light passing the sample is analysed). The latter method is used for e.g. transparent foils. The light **re**mission of the foils is much weaker than **trans**mission of light. The light unit of the probe *PMT* is installed above the conveyor belt, the fibre optical sensors are integrated into a chute, receiving the light passed through the transparent samples.

The probe line *PTT* measures in reflection. The probes can be placed very close: 10 mm or even less is possible, permitting accurate identification also of shredded material. The probe line is delivered in units of 500 mm (standard) than can be linked without gaps to wider units.

A special feature of *KUSTA* is the possibility to attach a *PSP* probe (serves as hand scanner) to a *KUSTA 4004M*. That allows to identify manually material using the same *KUSTA* with no need to stop online identification. One free channel on the *KUSTA 4004M* will be used for the connection of the *PSP* probe. A separate identification software for the hand scanner may be loaded.



fibre cables

Probes are connected with the *KUSTA* by special fiber optical cables. The length can be chosen according to the requirement. Even lengths of more than 10 m are possible, although for commercial reasons not suggested. Special fibres are used, limiting the diminution of the relevant light signals transferred.

LLA designed special plugs, limiting light scattering at the transfer points between probe - fibre cable and fibre cable - *KUSTA*.

Areas of application

KUSTA 4004M is already practise proven world-wide in the recycling for plastics and paper.

But a wide number of other applications are possible, e.g.:

- Analysis of fat contents in cookies on conveyor belts
- Identification of plastic packaging remains in cotton
- Identification of unwanted material in straw
- Evaluation of minerals

Identification of plastics

Identification household plastics and WEEE

PP	ABS	PS
PE-LD	ABS/TBBPA	EPS
PE-HD	PVC+ABS	PS/TBBPA
PC	PC+ABS	PPE+SB
PET	PC+PBT	PMMA
PET-G	PA6	POM
PVC	PA66	PUR

Identification biodegradable plastics

CA, CTA, PLA, PE (on cellulose basis)

Identification of foils

single layer	multi layer	
PE-LD, PE-HD, PET	PET layers:	PET-PE, PET-PP
PS, PVC, PP	PA layers:	PA-PE, PA-PP
	PP layers:	PP-PE, OPP-PE

Identification dark plastics

PP (PP+EPDM)	ABS	PVC
PC (PC+PBT)	PUR	

The identification of black plastics is performed up to carbon black content of max. one weight%.

Identification non plastics

Paper, TETRA

KUSTA Software

The *KUSTA* computers run Windows embedded. Apart from the operating software KustaMPL delivered with the *KUSTA*, a number of software tools are available. All have in common to be Windows applications.

KustaMPL

operating software for *KUSTA M*, responsible for spectra identification. Necessary and delivered with all *KUSTA M*.

Optional Software for *KUSTA M* includes KustaMonitor (Remote diagnostics), KustaBelt (online visualisation of belt load), KustaControl (setup and test program) and Backup (to create complete backups of LLA programs and settings).

For the qualitative and quantitative evaluation of plastics identification routines do already exist. For the development of customer specific applications KustaSpec is offered.

Technical data KUSTA 4004M

Measure method	contactless and destruction free measurement based on NIR spectroscopy; measurement of absolute remission depending on wave length
Wave length band	1400 to 1910 nm
Dispersion per pixel	2 nm
No. of probes	1 to 64
Base device	Spectrograph, control electronics, industrial PC
Dimensions	600 mm x 610 mm x 515 mm including air conditioning unit: width 720 mm
Weight	56 kg (net) KUSTA 4004M only
PC configuration	Operating system Windows XP Embedded; Pentium M 1,8 GHz, RAM 512 MB, solid state disk 32 GB
Ports	VGA, PS/2 keyboard, COM, USB, Ethernet
Software	KustaMPL, incl. Applications- and analytical software according to chosen Application Optional: spectrometric development software
Temp. interval	+ 0 to + 40 °C
Humidity	20 to 80%
Voltage	230 V ~ 50 Hz, fuse 4 A (optional 115 V ~ 60 Hz)



LLA Instruments GmbH is a world-wide acting manufacturer and supplier of spectroscopic measuring devices for general laboratory applications and advanced chemometrical analysis.

Business units of LLA are:

- instrumental analysis for the evaluation of products or waste in production processes
- high performance off-line analysis for production or laboratory
- accurate and rapid food analysis.

LLA staff has a broad expertise in device and software development on a high technological level, as well as a broad experiences in the integration of measuring techniques in different processes.

Contact

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